

## **FINAL INDOOR DIOXIN ASSESSMENT REPORT**

**SITE NAME:** Ringwood Mines Landfill Site – RS023  
**DC NO.:** RST 2-02-F-2676  
**TDD NO.:** TO-0029-0012

**EPA SITE ID NO.:** NJD980529739

**SAMPLING DATE:** July 2, 2013

**1. Sample Locations:** Refer to Attachment A, Table 1, Wipe Sample Collection Information Table

### **2. Introduction:**

In 2012, The United States Environmental Protection Agency's (EPA) Removal Action Branch was requested to assess residential properties for the presence of dioxin and related compounds in the vicinity of the Ringwood Mines Superfund Site (the Site). The justification for the Indoor Dioxin Assessments was based upon historical landfill fires during the deposition of wastes at the Site and the possible aerial deposition of particulates on surrounding residential properties. As a result, residents requested that EPA conduct voluntary indoor residential dioxin testing to determine if any residential properties had been impacted by previous operations conducted at the Site.

This report has been prepared to document the activities which were completed in support of the Indoor Dioxin Assessment. For privacy reasons, the name and address of this property will not appear within this report. Instead the property was assigned a unique identifier number - RS023.

### **3. Indoor Dioxin Assessment Summary:**

On July 2, 2013, Weston Solutions, Inc., Removal Support Team 2 (RST 2) mobilized to the Site to conduct Indoor Dioxin Assessment sampling activities at the property referred to by RST 2 as RS023. Sampling was conducted in accordance with the EPA Environmental Response Team (ERT) Standard Operating Procedure (SOP): #2011, *Chip, Wipe, and Sweep Sampling*, dated November 1994. Two sample locations were chosen: one in a high occupancy area (i.e., the living room) and one in the attic. Dioxins refer to a group of toxic chemical compounds that share certain chemical structures and biological characteristics. Dioxins can be released into the environment through forest fires, backyard burning of trash, certain industrial activities, and residue from past commercial burning of waste. Dioxins breakdown very slowly and past releases of dioxin from both man-made and natural sources still exist in the environment. Other sources include the incomplete combustion of firewood or cooking oils and grease; therefore, areas where combustion may occur, such as kitchens and fireplaces, were avoided. The attic was chosen as a sample location because of the presence of air circulation vents open to the exterior of the residence, which may have become collection areas of external smoke from the landfill fires.



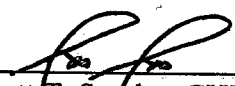
Wipe samples were collected by surrounding an area with a 100-square centimeter (cm<sup>2</sup>) template and wiping the area with a 15-cm by 15-cm Ghost Wipe™ sterile sampling pad soaked with hexane. The surface area sampled was wiped vertically and then horizontally to ensure complete surface coverage for sample collection. The wipe samples were then placed in 2-oz. glass jars for shipment to the laboratory. As part of the Indoor Dioxin Assessment sampling activities conducted on July 2, 2013, RST 2 collected two wipe samples from the RS023 property. The wipe samples collected from RS023 on July 2, 2013 were shipped to an EPA Contract Laboratory Program (CLP) laboratory, Analytical Resources, Inc., of Tukwila, Washington, on July 16, 2013 for dioxin/furan analysis under Chain of Custody (COC) Record No. 2-070213-102627-0029. Wipe sample collection information can be found in Attachment A, Table 1. In addition, photographic documentation can be found in Attachment B. The COC Record is presented in Attachment C.

#### 4. Analytical Discussion

Dioxins are a group of compounds that share distinct chemical structures and characteristics. The term "dioxin" commonly refers to the compound in this group considered most toxic, 2,3,7,8-tetrachlorodibenzo-para-dioxin (2,3,7,8-TCDD). Other dioxin-like compounds (DLCs) are typically found in combination with 2,3,7,8-TCDD. Toxicity Equivalence Factors (TEFs) are used as a measure of toxicity of DLCs relative to 2,3,7,8-TCDD. Concentrations of DLCs in environmental media are modified by TEFs to determine the concentration of each DLC that is equivalent to a concentration of 2,3,7,8-TCDD. The modified DLC concentrations are expressed in terms of 2,3,7,8-TCDD toxicity equivalence (TEQ) (i.e., dioxin). An EPA Fact Sheet: Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites, is presented in Attachment D.

Analytical results of the initial wipe samples collected on July 2, 2013 indicated Total 2,3,7,8-TCDD TEQs of 0.303 nanograms per square meter (ng/m<sup>2</sup>) and 0.136 ng/m<sup>2</sup>. All sample results were compared to the EPA Risk Assessment Screening Value of 0.9 ng/m<sup>2</sup>. Sample analytical results indicated that dioxin concentrations were below the 0.9 ng/m<sup>2</sup> screening value. Refer to Attachment A, Table 2 for the 2,3,7,8-TCDD Toxicity Equivalence Summary Table and Attachment C for the validated laboratory data.


5. Report Prepared By:

  
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Date

1/9/14

6. Report Reviewed By:

  
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Peter Lisichenko  
Group Leader, RST 2

Date

1/9/14

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## **ATTACHMENT A**

- Table 1: Wipe Sample Collection Information Table (RS023)
  - Table 2: 2,3,7,8-TCDD Toxicity Equivalence Summary Table (RS023)
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**Table 1**  
**Wipe Sample Collection Information Table**  
**Ringwood Mines Landfill Site (RS023)**  
**July 2, 2013**

<b>Sample No.</b>	<b>Sample Date</b>	<b>Sample Time</b>	<b>Media</b>	<b>Analysis</b>	<b>Collection</b>	<b>Sample Type</b>	<b>Location Description</b>
RS023-IW01-001	7/2/2013	0915	Wipe	Dioxins/Furans	Grab	Field Sample	Living room
RS023-AW01-001	7/2/2013	0935	Wipe	Dioxins/Furans	Grab	Field Sample	Attic
RS023-FB01-001	7/2/2013	0945	Wipe	Dioxins/Furans	Grab	Field Blank	N/A
RS023-LB01-001	7/2/2012	0950	Wipe	Dioxins/Furans	Grab	Lot Blank	N/A

N/A = Not applicable.

**Table 2**  
**2,3,7,8-TCDD Toxicity Equivalence Summary Table**  
**Interior Wipe Samples**  
**Ringwood Mines Landfill Site (RS023)**  
**July 2, 2013**

<b>Field Sample ID:</b>	<b>RS023-IW01-001</b>	<b>RS023-AW01-001</b>
<b>Sample Date:</b>	<b>7/2/2013</b>	<b>7/2/2013</b>
<b>CLP Sample ID:</b>	<b>BAZ11</b>	<b>BAZ12</b>
<b>Comment:</b>	<b>Living Room</b>	<b>Attic</b>
<b>Total 2,3,7,8-TCDD TEQ*</b>	<b>0.303</b>	<b>0.136</b>

All concentrations presented in nanograms per square meter (ng/m<sup>2</sup>).

CLP = Contract Laboratory Program.

TCDD = Tetrochlorodibenzo-para-dioxin.

TEQ = Dioxin toxicity equivalence.

\*World Health Organization (WHO) 2005 Toxicity Equivalence Factors (TEFs) used to calculate Total 2,3,7,8-TCDD TEQ.

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## **ATTACHMENT B**

- **Photographic Documentation**
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**Photographic Documentation  
Ringwood Mines Landfill Site  
Indoor Dioxin Assessment – RS023  
July 2, 2013**



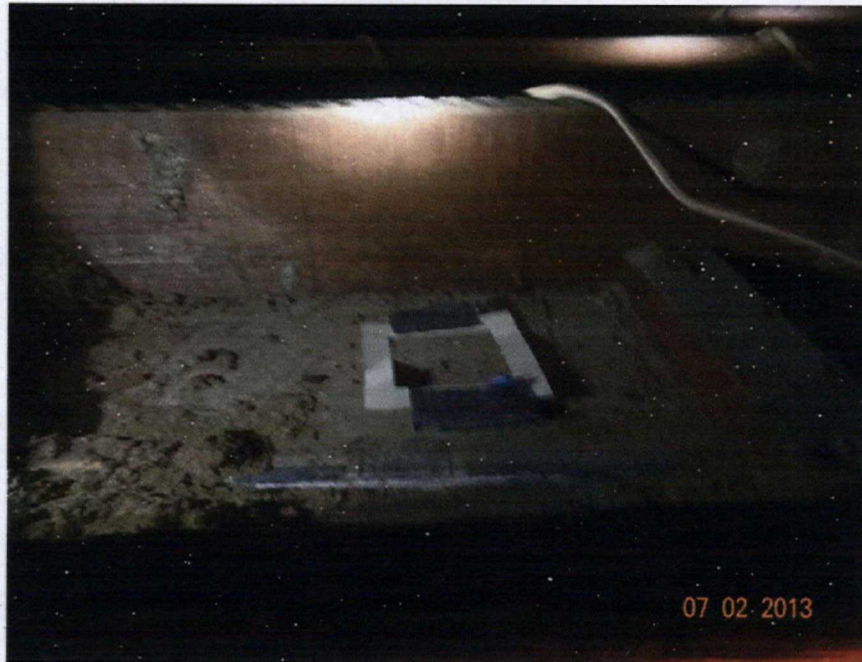
Photograph No. 1: Wide angle view of Wipe Sample Location RS023-IW01-001, living room television stand.



Photograph No. 2: Wipe Sample Location RS023-IW01-001.



**Photographic Documentation  
Ringwood Mines Landfill Site  
Indoor Dioxin Assessment – RS023  
July 2, 2013**



Photograph No. 3: Wide angle view of Wipe Sample Location RS023-AW01-001, exposed sheetrock adjacent to attic access hatch.



Photograph No. 4: Wipe Sample Location RS023-AW01-001.



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## **ATTACHMENT C**

o Chain of Custody Record and  
Validated Laboratory Analytical Results

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## Sample Summary Report

Case No:	43627	Contract:	EP10W001184	SDG No:	BAZ11	Lab Code:	ARI
Sample Number:	BAZ11	Method:	Dioxin	Matrix:	Wipe	MA Number:	2196.1
Sample Location:	RS023-IW01-001	pH:		Sample Date:	07/02/2013	Sample Time:	09:15:00
% Moisture :		% Solids :	Not Requested				

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-TCDD	0.00230	ng/wipe	1.00	BJY	JEMPC	Yes	S2AVEM
2,3,7,8-TCDF	0.000758	ng/wipe	1.00	BJ	J	Yes	S2AVEM
1,2,3,7,8-PeCDF	0.00246	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,7,8-PeCDD	0.00219	ng/wipe	1.00	J	J	Yes	S2AVEM
2,3,4,7,8-PeCDF	0.00158	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,4,7,8-HxCDF	0.00129	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,6,7,8-HxCDF	0.00178	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,4,7,8-HxCDD	0.00110	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,6,7,8-HxCDD	0.00146	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8,9-HxCDD	0.00156	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
2,3,4,6,7,8-HxCDF	0.00200	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8,9-HxCDF	0.00159	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDF	0.0113	ng/wipe	1.00	Y	EMPC	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDD	0.00855	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,4,7,8,9-HpCDF	0.000860	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
OCDD	0.0928	ng/wipe	1.00	B		Yes	S2AVEM
OCDF	0.00704	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
Total TCDD	0.00230	ng/wipe	1.00	BJY	J	Yes	S2AVEM
Total PeCDD	0.00219	ng/wipe	1.00	J	J	Yes	S2AVEM
Total HxCDD	0.00413	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDD	0.0184	ng/wipe	1.00	J	J	Yes	S2AVEM
Total TCDF	0.000758	ng/wipe	1.00	BJ	J	Yes	S2AVEM
Total PeCDF	0.00546	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HxCDF	0.0119	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDF	0.0197	ng/wipe	1.00	JY	J	Yes	S2AVEM
TEQ WHO1998 Bird	0.00373	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO1998 Fish	0.00338	ng/wipe	1.00			Yes	S2AVEM

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
TEQ WHO2005	0.00303	ng/wipe	1.00			Yes	S2AVEM



Case No: 43627	Contract: EP10W001184	SDG No: BAZ11	Lab Code: ARI
Sample Number: BAZ12	Method: Dioxin	Matrix: Wipe	MA Number: 2196.1
Sample Location: RS023-AW01-001	pH:	Sample Date: 07/02/2013	Sample Time: 09:35:00
% Moisture :		% Solids : Not Requested	

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-TCDD	0.000520	ng/wipe	1.00	U	U	Yes	S2AVEM
2,3,7,8-TCDF	0.00186	ng/wipe	1.00	BJ	J	Yes	S2AVEM
1,2,3,7,8-PeCDF	0.00218	ng/wipe	1.00	JX	JEMPC	Yes	S2AVEM
1,2,3,7,8-PeCDD	0.000980	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
2,3,4,7,8-PeCDF	0.00168	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,4,7,8-HxCDF	0.00200	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,6,7,8-HxCDF	0.00154	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,4,7,8-HxCDD	0.000740	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,6,7,8-HxCDD	0.00194	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,7,8,9-HxCDD	0.00130	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
2,3,4,6,7,8-HxCDF	0.00162	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8,9-HxCDF	0.00110	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDF	0.0135	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,6,7,8-HpCDD	0.0256	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,7,8,9-HpCDF	0.000648	ng/wipe	1.00	J	J	Yes	S2AVEM
OCDD	0.263	ng/wipe	1.00	B		Yes	S2AVEM
OCDF	0.0163	ng/wipe	1.00	J	J	Yes	S2AVEM
Total TCDD	0.00228	ng/wipe	1.00			Yes	S2AVEM
Total PeCDD	0.00718	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HxCDD	0.0142	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDD	0.0510	ng/wipe	1.00			Yes	S2AVEM
Total TCDF	0.0158	ng/wipe	1.00	BJ	J	Yes	S2AVEM
Total PeCDF	0.0186	ng/wipe	1.00	J	J	Yes	S2AVEM
Total HxCDF	0.0222	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDF	0.0254	ng/wipe	1.00	J	J	Yes	S2AVEM
TEQ WHO1998 Bird	0.003752	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO1998 Fish	0.001151	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO2005	0.00136	ng/wipe	1.00			Yes	S2AVEM

Case No: 43627	Contract: EP10W001184	SDG No: BAZ11	Lab Code: ARI
Sample Number: BAZ13	Method: Dioxin	Matrix: Wipe	MA Number: 2196.1
Sample Location: RS023-FB01-001	pH:	Sample Date: 07/02/2013	Sample Time: 09:45:00
% Moisture :		% Solids : Not Requested	

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-TCDD	0.00166	ng/wipe	1.00	BJY	JEMPC	Yes	S2AVEM
2,3,7,8-TCDF	0.000460	ng/wipe	1.00	BJY	JEMPC	Yes	S2AVEM
1,2,3,7,8-PeCDF	0.000840	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8-PeCDD	0.000780	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
2,3,4,7,8-PeCDF	0.000820	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,4,7,8-HxCDF	0.000660	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,6,7,8-HxCDF	0.000612	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,4,7,8-HxCDD	0.000420	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,6,7,8-HxCDD	0.000720	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8,9-HxCDD	0.000440	ng/wipe	1.00	U	U	Yes	S2AVEM
2,3,4,6,7,8-HxCDF	0.000500	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8,9-HxCDF	0.000300	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDF	0.000720	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDD	0.00126	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,4,7,8,9-HpCDF	0.000584	ng/wipe	1.00	J	J	Yes	S2AVEM
OCDD	0.00815	ng/wipe	1.00	BJ	J	Yes	S2AVEM
OCDF	0.000920	ng/wipe	1.00	U	U	Yes	S2AVEM
Total TCDD	0.00165	ng/wipe	1.00	BJY	J	Yes	S2AVEM
Total PeCDD	0.000772	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HxCDD	0.00140	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDD	0.00126	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total TCDF	0.000462	ng/wipe	1.00	BJY	J	Yes	S2AVEM
Total PeCDF	0.00167	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HxCDF	0.00178	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDF	0.00130	ng/wipe	1.00	JY	J	Yes	S2AVEM
TEQ WHO1998 Bird	0.0000679	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO1998 Fish	0.0000679	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO2005	0.0000695	ng/wipe	1.00			Yes	S2AVEM

Case No: 43627	Contract: EPI0W001184	SDG No: BAZ11	Lab Code: ARI
Sample Number: BAZ14	Method: Dioxin	Matrix: Wipe	MA Number: 2196.1
Sample Location: RS023-LB01-001	pH:	Sample Date: 07/02/2013	Sample Time: 09:50:00
% Moisture :		% Solids : Not Requested	

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-TCDD	0.00148	ng/wipe	1.00	BJY	JEMPC	Yes	S2AVEM
2,3,7,8-TCDF	0.000260	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,7,8-PeCDF	0.000360	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,7,8-PeCDD	0.000420	ng/wipe	1.00	U	U	Yes	S2AVEM
2,3,4,7,8-PeCDF	0.000400	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,7,8-HxCDF	0.000240	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,6,7,8-HxCDF	0.000220	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,7,8-HxCDD	0.000460	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,6,7,8-HxCDD	0.000480	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,7,8,9-HxCDD	0.000540	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
2,3,4,6,7,8-HxCDF	0.000280	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8,9-HxCDF	0.000280	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDF	0.000220	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDD	0.000718	ng/wipe	1.00	J	J	Yes	S2AVEM
1,2,3,4,7,8,9-HpCDF	0.000360	ng/wipe	1.00	U	U	Yes	S2AVEM
OCDD	0.00688	ng/wipe	1.00	BJY	JEMPC	Yes	S2AVEM
OCDF	0.000840	ng/wipe	1.00	U	U	Yes	S2AVEM
Total TCDD	0.00148	ng/wipe	1.00	BJY	J	Yes	S2AVEM
Total PeCDD	0.000420	ng/wipe	1.00	U	U	Yes	S2AVEM
Total HxCDD	0.00119	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDD	0.00153	ng/wipe	1.00	J	J	Yes	S2AVEM
Total TCDF	0.000260	ng/wipe	1.00	U	U	Yes	S2AVEM
Total PeCDF	0.000360	ng/wipe	1.00	U	U	Yes	S2AVEM
Total HxCDF	0.000278	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total HpCDF	0.000220	ng/wipe	1.00	U	U	Yes	S2AVEM
TEQ WHO1998 Bird	0.0000007	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO1998 Fish	0.0000007	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO2005	0.0000072	ng/wipe	1.00			Yes	S2AVEM

Case No: 43627	Contract: EP10W001184	SDG No: BAZ11	Lab Code: ARI
Sample Number: DFBK23	Method: Dioxin	Matrix: Wipe	MA Number: 2196.1
Sample Location: AS1-073013MBS	pH:	Sample Date: 07/30/2013	Sample Time: 13:24:00
% Moisture :	% Solids :		

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-TCDD	0.00134	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
2,3,7,8-TCDF	0.000740	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
1,2,3,7,8-PeCDF	0.000480	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,7,8-PeCDD	0.000500	ng/wipe	1.00	U	U	Yes	S2AVEM
2,3,4,7,8-PeCDF	0.000520	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,7,8-HxCDF	0.000340	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,6,7,8-HxCDF	0.000340	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,7,8-HxCDD	0.000540	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,6,7,8-HxCDD	0.000540	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,7,8,9-HxCDD	0.000560	ng/wipe	1.00	U	U	Yes	S2AVEM
2,3,4,6,7,8-HxCDF	0.000360	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,7,8,9-HxCDF	0.000420	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDF	0.000340	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,6,7,8-HpCDD	0.000540	ng/wipe	1.00	U	U	Yes	S2AVEM
1,2,3,4,7,8,9-HpCDF	0.000520	ng/wipe	1.00	U	U	Yes	S2AVEM
OCDD	0.00838	ng/wipe	1.00	JY	JEMPC	Yes	S2AVEM
OCDF	0.00104	ng/wipe	1.00	U	U	Yes	S2AVEM
Total TCDD	0.00134	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total PeCDD	0.000500	ng/wipe	1.00	U	U	Yes	S2AVEM
Total HxCDD	0.000540	ng/wipe	1.00	U	U	Yes	S2AVEM
Total HpCDD	0.000660	ng/wipe	1.00			Yes	S2AVEM
Total TCDF	0.00139	ng/wipe	1.00	JY	J	Yes	S2AVEM
Total PeCDF	0.000480	ng/wipe	1.00	U	U	Yes	S2AVEM
Total HxCDF	0.000340	ng/wipe	1.00	U	U	Yes	S2AVEM
Total HpCDF	0.000340	ng/wipe	1.00	U	U	Yes	S2AVEM
TEQ WHO1998 Bird	0.000000 0	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO1998 Fish	0.000000 0	ng/wipe	1.00			Yes	S2AVEM
TEQ WHO2005	0.000000 0	ng/wipe	1.00			Yes	S2AVEM



Case No:	43627	Contract:	EP10W001184	SDG No:	BAZ11	Lab Code:	ARI
Sample Number:	DLCS23	Method:	Dioxin	Matrix:	Wipe	MA Number:	2196.1
Sample Location:	AS1-073013OPRS	pH:		Sample Date:	07/30/2013	Sample Time:	14:16:00
% Moisture :				% Solids :			

Analyte Name	Result	Units	Dilution Factor	Lab Flag	Validation	Reportable	Validation Level
2,3,7,8-TCDD	0.204	ng/wipe	1.00			Yes	S2AVEM
2,3,7,8-TCDF	0.197	ng/wipe	1.00			Yes	S2AVEM
1,2,3,7,8-PeCDF	1.05	ng/wipe	1.00			Yes	S2AVEM
1,2,3,7,8-PeCDD	1.00	ng/wipe	1.00			Yes	S2AVEM
2,3,4,7,8-PeCDF	1.06	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,7,8-HxCDF	1.00	ng/wipe	1.00			Yes	S2AVEM
1,2,3,6,7,8-HxCDF	1.01	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,7,8-HxCDD	1.02	ng/wipe	1.00			Yes	S2AVEM
1,2,3,6,7,8-HxCDD	1.01	ng/wipe	1.00			Yes	S2AVEM
1,2,3,7,8,9-HxCDD	1.01	ng/wipe	1.00			Yes	S2AVEM
2,3,4,6,7,8-HxCDF	1.03	ng/wipe	1.00			Yes	S2AVEM
1,2,3,7,8,9-HxCDF	1.03	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,6,7,8-HpCDF	1.14	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,6,7,8-HpCDD	0.994	ng/wipe	1.00			Yes	S2AVEM
1,2,3,4,7,8,9-HpCDF	1.01	ng/wipe	1.00			Yes	S2AVEM
OCDD	2.04	ng/wipe	1.00			Yes	S2AVEM
OCDF	2.04	ng/wipe	1.00			Yes	S2AVEM

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## **ATTACHMENT D**

- **EPA Fact Sheet: Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites**
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## Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites

May 2013

### Purpose

This fact sheet provides information on the use of the 2005 World Health Organization (WHO) dioxin toxicity equivalence factors (TEFs) to calculate dioxin toxicity equivalence (TEQ) at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) sites contaminated with dioxins, furans, and polychlorinated biphenyls (PCBs). The approach provided in this fact sheet is for use at newly evaluated sites as well as for re-evaluating sites that have been previously cleaned up or screened from further consideration.

### Background

Dioxins are a group of compounds that share distinct chemical structures and characteristics. The term dioxin commonly refers to the compound in this group considered most toxic, 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD). Dioxin-like is a description used for compounds that have chemical structures, physico-chemical properties, and toxic responses similar to TCDD. Dioxin-like compounds (DLCs), including polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs), typically are found in mixtures with TCDD at CERCLA and RCRA sites and other contaminated properties. The EPA Toxics Release Inventory Program issued a final rule (EPA 2007) requiring that facilities report the released mass (grams) of individual DLCs in addition to reporting the released mass of TCDD.

The evaluation of TCDD and DLCs at CERCLA and RCRA sites includes consideration of the toxicity (i.e., cancer risks and non-cancer effects) of these contaminants. In the absence of toxicity values for DLCs, TEFs are used as a measure of the toxicity of the DLCs relative to TCDD. Concentrations of DLCs measured in media are modified by TEFs to determine the dose of each DLC in a medium that is equivalent to a dose of TCDD. The modified DLC doses are expressed in terms of TCDD toxicity equivalence (TEQ). The DLC TEQ concentrations are used, rather than the DLC concentrations measured in media, for site evaluations including site characterization, risk assessment, cleanup level development and confirmatory sampling.

The U.S. Environmental Protection Agency (EPA) Office of Research and Development released the *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin and Dioxin-Like Compounds* (EPA 2010), recommending the use of the 2005 human and mammalian WHO TEF values for DLCs. For additional information on the use of the 2005 WHO TEFs at CERCLA and RCRA sites, refer to EPA's 2010 TEF document.

This document does not impose any requirements or obligations on EPA, the states, other federal agencies, or the regulated community. It is important to understand that this document does not

substitute for statutes that EPA administers or their implementing regulations, nor is it a regulation itself. Thus, this document does not impose legally binding requirements on EPA, the states, or the regulated community, and may not apply to a particular situation based upon the specific circumstances. Rather, the document provides information that may be used at particular sites, as appropriate, given site-specific circumstances.

### Frequently Asked Questions

**Q:** What are toxicity equivalence factors (TEFs)?

**A:** 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (or TCDD) and DLCs, including polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (PCBs), typically occur as mixtures in environmental media. The toxicity of DLCs can be addressed by considering their toxicity relative to TCDD. EPA recommends using updated TEFs to assess human health risks from exposure to dioxin-like compounds (EPA 2010). A TEF for a DLC is a measure of the compound's toxicity relative to TCDD, which is assigned a TEF of 1. For example, 1,2,3,4,7,8-hexachloro-dibenzo-*p*-dioxin is considered one tenth as toxic as TCDD and has therefore been given a TEF of 0.1.

**Q:** For which media are the TEFs used?

**A:** The TEFs are most appropriate for dioxin exposures via the oral exposure route. Generally, the ingestion pathway for TCDD drives risk CERCLA and RCRA assessments. The TEFs can be used for evaluating the risk posed by the ingestion of soil, sediments, water, and fish contaminated with TCDD and DLCs.

**Q:** What is the basis for using the TEF approach for DLCs?

**A:** The TEF approach is based on the concept of dose addition, under which it is assumed that the toxicokinetics and toxicodynamics for all DLCs are similar, and that the DLCs act by a common toxic mode of action (i.e., for all DLCs, effects are mediated through aryl hydrocarbon receptor binding). Further, this approach assumes that toxicological interactions do not occur among the DLCs within the environmental mixtures being assessed (e.g., synergism and antagonism do not occur).

**Q:** What is toxicity equivalence (TEQ)?

**A:** For a single DLC, dioxin toxicity equivalence (TCDD TEQ) is the product of the concentration of the DLC in an environmental mixture and its corresponding TEF; total TEQ for the mixture is the sum of the individual TCDD TEQs across the DLCs. The TCDD TEQ provides a means for determining the toxicity of a mixture of DLCs, in the absence of toxicity values for these DLCs.

*The EPA's Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8- Tetrachlorodibenzo-*p*-dioxin and Dioxin-Like Compounds (EPA*



2010) provides a formula (reproduced below) for calculating the exposure concentration for  $n$  DLCs in a mixture, in TCDD TEQ. Exposure to the  $i$ th individual PCDD, PCDF, or PCB compound is expressed in terms of an equivalent exposure of TCDD by computing the product of the concentration of the individual compound ( $C_i$ ) and its assigned  $TEF_i$ . TEQ is then calculated by summing these products across the  $n$  DLCs present in the mixture.

$$TEQ = \sum_{i=1}^n (C_i \times TEF_i)$$

- $C_i$  Individual TCDD or DLC concentration in environmental media.
- $TEF_i$  Toxicity Equivalence Factor assigned for TCDD or the DLC.
- $TEQ$  TCDD toxicity equivalence.

Sample calculation:

Using the 2005 WHO TEFs (Van den Berg et. al. 2006), the TEQ for each DLC is estimated by multiplying the measured DLC concentration by the TEF corresponding to the DLC. The TEQ for the media sample is determined by summing the individual TEQ for TCDD with DLCs in the mixture. For example:

Individual concentration of TCDD and DLCs in an environmental sample:

2,3,7,8 TCDD.....	10 ppt (parts per trillion)
2,3,4,7,8- PeCDF .....	30 ppt
PCB 126.....	20 ppt

TEFs:

2,3,7,8 TCDD.....	1
2,3,4,7,8- PeCDF .....	0.5
PCB 126.....	0.1

Individual TEQ:

2,3,7,8 TCDD.....	10 ppt $\times$ 1 = 10 ppt TEQ
2,3,4,7,8- PeCDF .....	30 ppt $\times$ 0.5 = 15 ppt TEQ
PCB 126.....	20 ppt $\times$ 0.1 = 2 ppt TEQ

Total TEQ

10 ppt + 15 ppt + 2 ppt = 27 ppt TEQ

**Q:** For which exposure pathways are the TEFs used?

**A:** In addition to the ingestion pathway, the TEFs may be applied to other exposure routes (i.e., dermal or inhalation), as an estimate, assuming exposures to DLCs via these routes can be quantified. When included in an assessment, the fractional contribution of oral, dermal, and inhalation route exposures to the predicted TEQ should be identified.

In the absence of dermal toxicity values, a route-to-route (oral to dermal) extrapolation can be done using the oral toxicity value and adjusting for absorption through skin. This Office of Solid Waste and Emergency Response policy is described in Section 4.1 of the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final* (EPA 2004). The availability of a dermal absorption factor for TCDD allows for the use of the TEFs in evaluating dermal exposure.

The EPA Integrated Risk Information System (IRIS) does not include toxicity values for estimating the risk posed by the inhalation of TCDD (either via particulates or volatiles). The EPA Regional Screening Tables (EPA 2012) provide dioxin soil screening levels for the inhalation pathway based on the California EPA reference concentration (RfC) and unit risk factor for TCDD. Inhalation risk based on particulate emissions from soil, estimated using the California EPA RfC for TCDD, shows that the contribution of the inhalation pathway compared to the ingestion pathway is well below 1%.

**Q:** Are dioxin TEFs applied in assessing both cancer risks and non-cancer health effects?

**A:** The EPA 2010 TEF document (EPA 2010) recommends that the TEFs be used for all effects mediated through aryl hydrocarbon receptor binding by the DLCs, including cancer and noncancer effects.

**Q:** How is the EPA 2010 report *Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds* to be applied at CERCLA and RCRA sites?

**A:** The TEF approach has previously been used at CERCLA and RCRA sites. The EPA is now recommending the use of the 2005 human and mammalian WHO TEF values for DLCs, as discussed in the EPA 2010 TEF report (EPA 2010). This report provides updates to the 1998 WHO TEF values (Van den Berg et al 1998), based on a number of factors, including new toxicity values and the need to consider impurities in test compounds.

Some of the 2005 WHO TEFs have increased and some have decreased in value, compared to the 1998 WHO TEFs. The relative importance of the TEF changes largely depends on the mixture being evaluated. For example, the TEF for 2,3,4,7,8-pentachlorodibenzofuran was reduced from 0.5 to 0.3 and the TEF for PCB 169 increased from 0.01 to 0.03. See Attachment A for a comparison of the WHO 1998 and 2005 TEFs.

Underlying assumptions of the TEF method include: a) the toxicokinetics and the toxicodynamics of TCDD and DLCs are similar; b) the dose-response curves of TCDD and DLCs are similarly shaped; c) the aryl hydrocarbon receptor mediates most if not all of the biologic and toxic effects of the DLCs; and d) the kinetics and potency of various DLCs are generally similar between species (EPA 2000, EPA 2008). EPA recommends that risk assessors identify the fraction of the total TEQ attributable to TCDD (for which

uncertainty is relative low) and attributable to DLCs (for which uncertainty is somewhat higher).

**Q:** The EPA issued a report in 2010 on the use of dioxin TEFs for human health risk assessments. Does the Agency have information on the use of TEFs for ecological risk assessments?

**A:** Yes. In 2008, the EPA issued the *Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment* (EPA 2008).

**Q:** How are the dioxin TEFs used at PCB sites?

**A:** There are 209 PCB chemical compounds, or congeners; 12 of the 209 PCB congeners are considered dioxin-like. If dioxin-like PCBs are of concern at a PCB site, the PCB cleanup level will need to meet a site-specific dioxin TEQ cleanup level. In this case, two PCB cleanup levels are calculated. One cleanup level is calculated for total PCBs (i.e., for all PCB congeners present), based on toxicity values for total PCBs. The other PCB cleanup level is calculated so that it meets a site-specific dioxin TEQ cleanup level. This second PCB cleanup level depends on the TEQ (i.e., concentration x TEF) of dioxin-like PCBs in the PCB-contaminated media along with any TCDD and other DLCs present, and considers toxicity values for TCDD. The more stringent of the two PCB cleanup levels is selected.

For example, the PCB soil cleanup level that will meet a site-specific dioxin TEQ soil cleanup level can be calculated as:

$$\text{PCB cleanup level for TCDD/DLCs} = \text{PCB soil concentration} \times \text{TEQ cleanup level} / \text{TEQ soil concentration}$$

Where:

- |                                   |   |
|-----------------------------------|---|
| • PCB cleanup level for TCDD/DLCs | PCB soil cleanup level that meets the dioxin TEQ soil cleanup level.                        |
| • PCB soil concentration          | Soil concentration of total PCBs.   |
| • TEQ cleanup level               | Dioxin TEQ soil cleanup level.  |
| • TEQ soil concentration          | Soil TEQ concentration of TCDD and DLCs, (i.e. other dioxins, furans and dioxin-like PCBs). |

The PCB soil cleanup level that will meet a site-specific dioxin TEQ soil cleanup level is compared to the site-specific soil cleanup level for total PCBs to select the more stringent of the two, ensuring that the remedy will be protective for both PCB and dioxin-like PCB (along with any TCDD and other DLC) exposures.

The following is a sample calculation:

$$\text{PCB cleanup level for TCDD/DLCs} = 5,000 \text{ ppt PCBs} \times 50 \text{ ppt TEQ} / 500 \text{ ppt TEQ}$$

PCB cleanup level for TCDD/DLCs = 500 ppt PCBs

In this example, one tenth of the total PCB concentration is due to dioxin-like PCBs, as well as any TCDD and other DLCs present (i.e., the dioxin-like PCB TEQ concentration, along with any TCDD and other DLCs present, is 500 ppt TEQ). For a soil dioxin cleanup level of 50 ppt TEQ, the corresponding PCB soil cleanup level that would not exceed the soil dioxin cleanup level is 500 ppt PCBs.

### **Additional Resources**

This fact sheet provides information on the use of the 2005 WHO TEFs to calculate TEQs at CERCLA and RCRA sites. Additional information on evaluating TCDD and DLCs at these sites can be found online at: <http://epa.gov/superfund/health/contaminants/dioxin/dioxinsoil.html>

Attachment A "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of Polychlorinated Dibenzo-p-dioxins, Dibenzofurans, and Dioxin-Like Polychlorinated Biphenyls" provides the 2005 updates to the 1998 WHO TEFs.

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## ATTACHMENT A

### Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessment of Polychlorinated dibenzo-*p*-dioxins, Dibenzofurans, and Dioxin-Like Polychlorinated Biphenyls<sup>1</sup>

Compound	1998 TEF <sup>2</sup>	2005 TEF <sup>3</sup>
<b>Polychlorinated dibenzo-<i>p</i>-dioxins (PCDDs)</b>		
2,3,7,8-Tetrachloro-dibenzo- <i>p</i> -dioxin (TCDD)	1	1
1,2,3,7,8-Pentachloro dibenzo- <i>p</i> -dioxin (PeCDD)	1	1
1,2,3,4,7,8-Hexachloro- dibenzo- <i>p</i> -dioxin (HxCDD)	0.1	0.1
1,2,3,6,7,8-Hexachloro- dibenzo- <i>p</i> -dioxin (HxCDD)	0.1	0.1
1,2,3,7,8,9-Hexachloro- dibenzo- <i>p</i> -dioxin (HxCDD)	0.1	0.1
1,2,3,7,8,9-Heptachloro- dibenzo- <i>p</i> -dioxin (HpCDD)	0.01	0.01
Octachloro-dibenzo- <i>p</i> -dioxin (OCDD)	<b>0.0001</b>	<b>0.0003</b>
<b>Polychlorinated dibenzofurans (PCDFs)</b>		
2,3,7,8-Tetrachlor-dibenzofuran (TCDF)	0.1	0.1
1,2,3,7,8-Pentachloro-dibenzofuran (PeCDF)	<b>0.05</b>	<b>0.03</b>
2,3,4,7,8-Pentachloro-dibenzofuran (PeCDF)	<b>0.5</b>	<b>0.3</b>
1,2,3,4,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
1,2,3,6,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
1,2,3,7,8,9-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
2,3,4,6,7,8-Hexachloro-dibenzofuran (HxCDF)	0.1	0.1
1,2,3,4,6,7,8-Heptachloro-dibenzofuran (HpCDF)	0.01	0.01
1,2,3,4,7,8,9-Heptachloro-dibenzofuran (HpCDF)	0.01	0.01
Octachloro-dibenzofuran (OCDF)	<b>0.0001</b>	<b>0.0003</b>
<b>Polychlorinated biphenyls (PCB congener number)</b>		
3,3',4,4'-Tetrachloro-biphenyl (77)	0.0001	0.0001
3,4,4',5-Tetrachloro-biphenyl (81)	<b>0.0001</b>	<b>0.0003</b>
3,3',4,4',5-Pentachloro-biphenyl (126)	0.1	0.1
3,3',4,4',5,5'-Hexachloro-biphenyl (169)	<b>0.01</b>	<b>0.03</b>
2,3,3',4,4'-Pentachloro-biphenyl (105)	<b>0.0001</b>	<b>0.00003</b>
2,3,4,4',5-Pentachloro-biphenyl (114)	<b>0.0005</b>	<b>0.00003</b>
2,3',4,4',5-Pentachloro-biphenyl (118)	<b>0.0001</b>	<b>0.00003</b>
2',3,4,4',5-Pentachloro-biphenyl (123)	<b>0.0001</b>	<b>0.00003</b>
2,3,3',4,4', 5-Hexachloro-biphenyl (156)	<b>0.0005</b>	<b>0.00003</b>
2,3,3',4,4',5'-Hexachloro-biphenyl (157)	<b>0.0005</b>	<b>0.00003</b>
2,3',4,4',5,5'-Hexachloro-biphenyl (167)	<b>0.00001</b>	<b>0.00003</b>
2,3,3',4,4',5,5'-Heptachloro-biphenyl (189)	<b>0.0001</b>	<b>0.00003</b>

<sup>1</sup> Numbers in bold indicate a change in TEF value.

<sup>2</sup> Source: van den Berg et al. (1998); available at: <http://www.cerc.usgs.gov/pubs/center/pdfDocs/90970.pdf>

<sup>3</sup> Source: van den Berg et al. (2006); WHO's Web site on dioxin TEFs, available at: [http://www.who.int/ipcs/assessment/tef\\_update/en/](http://www.who.int/ipcs/assessment/tef_update/en/)